2000 WASHINGTON STATE

SALMONID STOCK INVENTORY

COASTAL CUTTHROAT TROUT

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WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

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REPORT AVAILABILITY

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INTRODUCTION

In 1993, the Washington Departments of Fish and Wildlife (WDFW), along with the Western Washington Treaty Indian Tribes, provided initial results of a stock status inventory for salmon and steelhead (SASSI) in Washington State (Washington Department of Fisheries et al. 1993). WDFW is extending that effort to other salmonid species and has published the 1997 Salmonid Stock Inventory - Bull Trout and Dolly Varden Appendix, updated in 1998. The present report is a stock status report for coastal cutthroat trout (*Oncorhynchus clarki clarki*) in Washington State. This inventory expands upon the Washington Department of Game Sea-Run Cutthroat Status Report (DeShazo 1980).

Resource inventories are key steps in statewide efforts to maintain and restore wild[1] salmonid stocks and fisheries. The primary intent of these efforts is to identify currently available information and to guide future restoration planning and implementation. Assessment of specific management objectives, strategies and implementation alternatives will be among the many subsequent steps (e.g., development of a coastal cutthroat management plan) aimed at improving the status of native trout populations.

BACKGROUND

Species Distribution and Evolution

Coastal cutthroat trout are a subspecies of cutthroat trout (*O. clarki*) which includes three other subspecies, westslope cutthroat (*O. c. lewisi*), Lahontan cutthroat (*O. c. henshawi*) in the western Rocky Mountains and Yellowstone cutthroat (*O. c. bouveri*) in the Snake River basin and its subspecies (Behnke 1997).

Coastal cutthroat trout are distributed along the Pacific coast of North America from Prince William Sound in Alaska to the Eel River in northern California, an area that conforms to the coastal rain forest belt (Trotter 1997). In Washington, they are found in the western part of the state including the coast, Puget Sound and the Columbia River as far east as the Klickitat River.

It is thought that at the beginning of the Pleistocene Era, about two million years ago, a common western trout ancestral species diverged into two lines, one leading to cutthroat trout and another leading to rainbow trout. About a million years ago, the cutthroat line separated into the coastal

[1] The term "wild stock" as used in this report refers to how fish reproduce, i.e. by spawning and rearing in the natural habitat, regardless of parentage, and does not refer to genetic heritage. The origin (native, non-native or mixed) and parentage (wild, cultured or composite) of individual stocks are specifically designated in this report where known. This terminology is not intended to diminish the importance of wild stocks but rather emphasizes the need to protect a wide range of genetic resources maintained by natural reproduction. The terms "natural" and "wild" spawners are used synonymously as are the terms "stocks" and "spawning populations" (See Part 1--Stock Definition and Identification).

and westslope forms and the westslope form gave rise to the Lahontan and Yellowstone forms (Behnke 1997).

Life History

Coastal cutthroat have four life history forms. The basic division of life history is between the anadromous (sea-run) form and the forms living strictly in fresh water. The freshwater forms are fluvial (riverine), adfluvial (lacustrine) and resident (headwaters). Depending on specific watershed characteristics, all forms can occur within a single watershed.

Coastal cutthroat exhibit the broadest range of occupied habitats, migratory behavior, age at first spawning and frequency of repeat spawning of any salmonids (Johnston 1981, Northcote 1997). Life histories and ecology of coastal cutthroat have been described in a number of sources including Sumner (1972), Tipping and Springer (1980), Tipping (1981), Johnston (1981), June (1981), Fuss (1982), Michael (1983), Trotter (1989, 1997), and Johnson et al. (1999).

Anadromous coastal cutthroat, or sea-run cutthroat, typically spawn in small streams as do the other life history forms. Unlike juveniles of the life history forms which remain in fresh water, anadromous juveniles undergo the morphological, physiological and behavioral changes required for migration and adaptation to salt water. They return to fresh water to overwinter and spawn. Fish which survive spawning return to salt water, and the cycle is repeated.

In Washington, most anadromous coastal cutthroat spawn from January through April with the peak of spawning in February. Spawning occurs in riffles where the water depth is about 15 to 45 cm, in areas of low gradient and low flow (Johnston 1981, Trotter 1989). Females construct redds in pea-size gravel, usually near pools (Hunter 1973, Jones 1978). Johnston and Mercer (1976) found that females ranging in length from 37 to 41 cm contain 1,000 to 1,200 eggs. Fecundity varies with size and age. Second-time and third-time spawning females produce more eggs and larger eggs than first-time spawning females.

Anadromous females rarely mature before age four (Johnston 1981, Fuss 1982). Fuss (1982) observed that the majority (84%) of anadromous females returning to north Washington coast streams did not mature until age five.

The link between the first return to fresh water and spawning varies among coastal cutthroat populations. In Sand Creek (Oregon), Sumner (1953) found that nearly all migrants returning to fresh water were sexually mature, with most first time spawners maturing during their first winter in fresh water. Fuss (1982) also found that in north coast Washington streams, most fish returning to fresh water for the first time matured during their first winter in fresh water. However, in the Columbia River about half the coastal cutthroat returning to fresh water for the first time did not mature during their first winter (Tipping 1981). In Puget Sound, most first time returning males matured over the winter, however only 20 to 27% of first-time returning females matured in their first winter in fresh water (Johnston 1981). Immature fish are observed overwintering in non-natal streams, however sexually mature fish appear to return to their natal streams to spawn with high fidelity (Trotter 1989)

In Washington adults surviving spawning tend to return to salt water in late March and early April (Trotter 1989). Survival after spawning and the number of times an anadromous fish spawns during its lifetime are variable. Johnston and Mercer (1976) observed that 41% of spawned-out adults survived to return to salt water. Sumner (1953) found that in the absence of fisheries, 39% of anadromous coastal cutthroat returned to spawn a second time, 17% spawned a third time and 12% spawned a fourth time. In the Alsea River, Oregon, where there was an intense fishery, less than 14% of first-time spawners survived to spawn a second time (Giger 1972). Some adults do not spawn every year, and some remain in fresh water for a year rather than returning to salt water after spawning. Individual fish may spawn as often as six times (Johnson et al. 1999).

Eggs hatch within six to seven weeks, depending on water temperature, and alevins remain in the gravel for about two weeks after hatching (Trotter 1989). In Washington, fry emerge from spawning gravels from March through June (Johnson et al. 1999). Survival during the critical time when eggs and alevins are in gravel is reduced by siltation and flooding, which are often exacerbated by land-use activities. Newly-emerged fry move quickly to low velocity water at stream margins and backwaters and remain there through the summer to feed (Trotter 1989). However in the presence of coho juveniles, which emerge earlier and at a larger size, cutthroat are often driven into higher-velocity waters. Johnston (1981) suggested that cutthroat spawning in very small streams may isolate juveniles and minimize potentially harmful interactions with other salmonids. Juveniles tend to move to log jams and overhanging banks to shelter during winter. They tend to remain in small streams for about a year then begin to migrate over longer distances within their natal river system (Johnson et al. 1999).

Most juveniles remain in freshwater for two to four years before smolting and migrating to salt water, though the range extends from one to six years (Giger 1972, Lowery 1975). Emigration occurs in the spring. In the relatively sheltered waters of Puget Sound, smolts are predominantly two years old with a mean fork length of 16 cm (Johnston 1979, Michael 1980). In the Columbia River, with its large estuary, most smolts are two to three years old, also with a mean fork length of 16 cm (Chilcote 1980). However on the coast, where many rivers enter rough ocean waters directly with very little in the way of estuaries, smolts are two to three years old and tend to be larger, 15 to 23 cm (Giger 1972, Sumner 1972, Fuss 1982).

Once reaching salt water, coastal cutthroat are generally thought to remain fairly close to shore or within estuaries. However they are sometimes caught in open marine waters many miles from shore (Loch 1982, Pearcy 1997). It is unclear whether they are carried there by freshwater plumes or migrate volitionally (Johnson et al. 1999).

After feeding in salt water and estuaries for several months, most anadromous coastal cutthroat return to fresh water to overwinter and spawn. Size at freshwater return varies since coastal cutthroat remain at sea for different lengths of time and return at different ages. In Puget Sound, two river entry times, early and late, are seen. Fish returning to larger river systems with higher summer flows tend to enter from August through October (early-entry timing) while those returning to smaller streams with lower summer flows tend to return from November through March (late-entry timing) when flows are higher.

Anadromous coastal cutthroat were probably once present in all coastal and Puget Sound streams accessible to anadromous fish. Before construction of the Bonneville Dam, they are believed to have ascended the Columbia River as far as the Klickitat River (Bryant 1949).

Historical abundance information for anadromous coastal cutthroat is scarce and generally limited to sport catch, fish trap and dam count data from a few river systems. These data, which often provide relative, rather than actual abundances, are presented in individual stock complex reports in this volume. It is believed that historic population levels were never large, especially compared to other anadromous salmon and trout populations. Royal (1972) suggested that anadromous coastal cutthroat abundances are probably less than those of steelhead, which comprise only 2-3% of anadromous fish in Washington.

Fluvial coastal cutthroat feed and grow in mainstem rivers in much the same way that anadromous populations use salt water (Trotter 1989). As with all coastal cutthroat life history forms, fluvial fish tend to move upstream to spawn in small streams (Trotter 1989). Tomasson (1978) found that in the Rogue River (Oregon), fluvial coastal cutthroat spawned higher up in tributaries than the anadromous form, however the spawning areas of the two types frequently overlap. Fluvial fish can be located above or below natural barriers, such as waterfalls.

In Washington, fluvial spawning occurs from January through mid-June. Incubation time and early juvenile life history are thought to be similar to those of anadromous fish, however very little information is available on other fluvial life history details.

Adfluvial coastal cutthroat also spawn in small streams but migrate into lakes rather than into salt water or river mainstems to feed and grow. In Washington, adfluvial spawning time extends from January through July. Time to hatching and early juvenile development are expected to be similar to those in anadromous fish. Juveniles may spend from one to three years in tributaries before migrating to lakes. Pierce (1984), in his study of Crescent Lake (north coast Olympic Peninsula) cutthroat, recorded some first-time spawning at age three, but more commonly first-time spawning occurred at age four. He also found that these fish subsequently spawned nearly every year for the rest of their lives, and used both inlet and outlet tributaries for spawning.

Resident coastal cutthroat are non-migratory and live their entire lives in small streams. Because the productivity of small streams is often low, resident fish tend to be much smaller than the other forms, rarely growing larger than 20 cm. They also tend to have shorter life spans (rarely more than four years) than the other life history forms (Wyatt 1959). As with adfluvial fish, spawning tends to extend later into the spring (May or even July) than with anadromous fish. Resident fish exhibit only limited instream movement. Juvenile fish tend to remain close to their natal redd (Moore and Gregory 1988), and as they grow they may drift downstream 25 to 100 meters (Wyatt 1959, June 1981, Fuss 1982). There may be further downstream movement during the winter to areas that afford more secure habitat, but in the spring resident fish tend to return upstream. These seasonal movements are not extensive. Wyatt (1959) reported that less than three percent of the population ever moved more than 200 meters.

Genetic and behavioral relationships among these four life history types are unclear. In any stream system coastal cutthroat trout are rarely represented by only the anadromous form

(Northcote 1997). Often fish of more than one life history type are commingled in small spawning tributaries, and there may be considerable overlap in spawn time among the different forms. Little is known about the extent to which different life history forms spawn with one another. Size and spawn-timing differences may tend to reduce potential spawning among life-history forms. However, size may be influenced environmental factors such as food supply as well as by genetics. It may be that the life-history forms can buffer one another from adverse conditions. Some researchers have suggested that individuals from resident populations may become anadromous in numbers sufficient to maintain viable anadromous stocks (Royal 1972; Edie 1975; Jones 1979). However, Michael (1983), during his studies of coastal cutthroat in Snow and Salmon creeks near the Strait of Juan de Fuca, found no evidence that this occurred.

Campton (1981) and Johnston (1981) noted that coastal cutthroat behavior is affected by the presence of other salmonids in both the marine and freshwater environment. Hawkins (1997) grouped interactions with other species into three categories: 1) predation on or by cutthroat trout, 2) competition by resource depletion, 3) interference competition. In addition, hybridization occurs between cutthroat trout and steelhead, and this interaction could contribute to local declines of cutthroat trout, assuming some selection against hybrids (Hawkins and Foote 1998).

Management

In Washington State all life-history forms of coastal cutthroat are managed to achieve resource protection goals while providing recreational opportunity consistent with those goals. The general approach to trout management in Washington is presented in "A Basic Fishery Management Strategy for Resident and Anadromous Trout in the Stream Habitats of the State of Washington" (the Basic Stream Management Strategy) (Washington Department of Game (WDG) 1984).

In the past, trout management has been non-specific, i.e., designed for all species collectively in a stream. For example, catch regulations on the Stillaguamish River in the 1930s and 1940s allowed 20 game fish, or ten pounds and one fish. In addition, most of the tributaries were closed to protect spawning fish. By the 1950s, the limit was reduced to fifteen fish, not to exceed 7½ pounds and one fish, and by 1980 it was further reduced to six pounds and one fish, not to exceed eight trout.

Starting in the 1980's, freshwater regulations were made more specific and conservative for cutthroat. The Basic Stream Management Strategy (WDG 1984) sets minimum size limits intended to allow the majority of females to spawn at least once before being subject to harvest. In Puget Sound and north coastal rivers, regulations in most streams with anadromous cutthroat now allow a two-fish daily limit with a 14-inch minimum size limit. Along the south coast and lower Columbia tributaries, wild cutthroat release is generally required. In marine waters, recent regulations have been adopted requiring the release of all cutthroat trout in an attempt to reverse observed reduction in the numbers of larger, older fish. In non-anadromous waters, including headwater tributaries, there is presently a two-fish, eight-inch minimum, which protects the majority of resident coastal cutthroat.

By setting minimum size limits to provide at least one spawning opportunity, management effectively maintains exploitation rates at conservative levels, even in waters where absolute abundance is unknown. Minimum size regulations have been used in many areas with good success. In some cases they were implemented for “trophy trout” fisheries. However, they can also produce dramatic increases in trout populations, and curb overfishing. An example comes from the upper St. Joe River in Idaho (Bjornn and Johnson 1978).   After implementation of a 13-inch minimum-size limit, cutthroat abundance increased by 300% in road-access areas and 600% in trail-access areas, with annual mortality rates dropping from a range of 0.62-0.71 to 0.47-0.56. This resulted in a ten-fold increase in the spawner abundance.

Future fishery regulations will result in active management of all wild stocks as required in the Wild Salmonid Policy, which was adopted by WDFW in December, 1998. The policy includes guidance for harvest and hatchery management designed to achieve spawning escapement goals and maintain genetic diversity.

Washington Coastal Cutthroat Hatchery Program

In comparison with salmon and steelhead, relatively few coastal cutthroat hatchery programs have been established in Washington. Crawford (1979) reviewed the early history of these programs, and much of the information below is from that source.

In 1958 an anadromous coastal cutthroat program was established at the Beaver Creek Hatchery (Elochoman River tributary in the lower Columbia River basin). Wild fish from Beaver Creek , the Nemah River (Willapa Bay tributary), Green River (Toutle River tributary in the lower Columbia basin) and later from the Cowlitz River (lower Columbia basin) were captured to create the Beaver Creek brood stock. In 1963 the stock was augmented with fry from the State of Oregon's Bandon Hatchery on the southern Oregon coast. This stock originated from anadromous coastal cutthroat from the north fork of the Alsea River (Oregon). By 1972 the Beaver Creek brood stock was a mixture of native Washington fish, the Oregon hatchery stock and Beaver Creek coastal cutthroat-steelhead hybrids. Artificial selection favoring fish with cutthroat coloration and speckling was carried out to reduce the contribution of steelhead to the stock. The goal of the program is to provide coastal cutthroat for the recreational fisheries in the Elochoman River and nearby streams and lakes. Currently, goals for annual releases from Beaver Creek are 30,000 into the Elochoman drainage, 5,000 into the Coweeman drainage and 2,000 into Abernathy Creek. For several years in the 1970s, no cutthroat were released from the Beaver Creek Hatchery during an attempt to convert the anadromous program to a captive brood program. That program has since been discontinued. In early 2000, the hatchery was closed due to budget constraints.

A second anadromous coastal cutthroat program was initiated in the lower Columbia basin at the Cowlitz Trout Hatchery in 1968. Brood stock originated primarily from the Beaver Creek Hatchery and from a few wild Cowlitz River fish. The purpose of this program is to provide coastal cutthroat for fisheries in the Cowlitz River drainage (the hatchery releases more than 200,000 cutthroat into the Cowlitz system annually) and to provide eggs to support other coastal cutthroat hatchery programs.

An anadromous coastal cutthroat captive brood stock program was initiated at the Lake Aberdeen Hatchery near Grays Harbor on the Washington coast in the early 1980s to mitigate for lost wild cutthroat production associated with the Wynoochee Dam (Ashbrook and Fuss 1996).

The brood stock is derived from Grays Harbor and coastal streams coastal cutthroat with periodic infusions of wild fish from local streams.

In Puget Sound various programs have been initiated since the late 1940s. An anadromous coastal cutthroat hatchery program in Puget Sound was started in 1973 using coastal cutthroat from the Stillaguamish River and Hood Canal. The operation used saltwater net pen facilities at Manchester in attempt to rear coastal cutthroat in a captive brood program (Johnston and Mercer 1976). Besides testing saltwater net pen rearing for cutthroat, the primary goals were to: 1) increase the number of sea run cutthroat available to saltwater fishers and, 2) increase the natural production in Hood Canal and Puget Sound tributary streams. This program continued into the late 1970s, but was discontinued due to high mortality in the pens.

In the mid-1980s, anadromous cutthroat were collected from two south Puget sound tributaries, McLane and Minter creeks, and reared at a small facility on McAllister Creek, with the intent of developing an anadromous brood stock for enhancement purposes (Washington Department of Wildlife (WDW) 1988). For several years cutthroat juveniles were released, but there was little benefit to local fisheries, and the program was abandoned in 1990.

Presently, most releases of anadromous coastal cutthroat occur within Columbia River tributaries, particularly in the Cowlitz, Lewis and Washougal rivers. Smaller numbers of coastal cutthroat are released into Abernathy Creek on the lower Columbia. Total annual releases approximate 280,000 fish. All hatchery fish are marked with an adipose fin clip. The following table is summarized from the Draft 2000 Future Brood Document (WDFW 2000).

2000 ANADROMOUS CUTTHROAT HATCHERY RELEASES		
HATCHERY	**WATERSHED**	**RELEASE NUMBERS**
Cowlitz Trout Hatchery	Blue Creek	190,000
	Cowlitz River	40,000
Skamania Hatchery	Salmon Creek	12,000
Merwin Hatchery	NF Lewis River	25,000
Skamania Hatchery	Washougal River	10,000

In 1949 non-anadromous wild coastal cutthroat were captured from Lake Whatcom tributaries (north Puget Sound) and placed in a captive brood stock program at the Tokul Creek Hatchery in the Snoqualmie River drainage. Although only fish from Lake Whatcom were used to establish this brood stock, it is possible that there may have been some contribution from west slope cutthroat (*O. clarki lewisi*) from Twin Lakes in the Wenatchee River system following their release into Lake Whatcom in 1907. Lake Whatcom fish currently show no obvious signs of west slope influence. Tokul Creek coastal cutthroat have been widely released in western Washington streams, lakes and beaver ponds. Present releases of Tokul Creek resident cutthroat are limited to lakes which have no access to marine waters. The 1998 releases totaled approximately 170,000 fish into lakes in Whatcom, Skagit, Island, Snohomish, King, Jefferson, Mason, Pierce and Thurston counties. The Tokul Creek brood stock is now maintained at the Tokul Creek and Eells Spring (Skokomish River basin) hatcheries.

<u>Endangered Species Act</u>

Following listing of North Fork Umpqua River (Oregon) sea-run coastal cutthroat as endangered under the federal Endangered Species Act (Johnson et al. 1997) the National Marine Fisheries Service (NMFS) began a coastwide status review for sea-run coastal cutthroat, including Washington populations. General threats to coastal cutthroat include loss of habitat due to logging practices, road building, passage obstructions (e.g., dams, poorly designed culverts which block fish passage), water diversions, mining, and livestock grazing as well as harvest and poaching. Other threats include interspecific competition (especially with coho), and hybridization with steelhead and rainbow trout. In March 1999 NMFS proposed listing coastal cutthroat as threatened in the Lower Columbia/Southwest Washington ESU. Coastal cutthroat stocks elsewhere in Washington were not proposed for listing. The final listing decision from NMFS is expected during the month of March 2000.

WILD STOCK RESTORATION INITIATIVE AND WILD SALMONID POLICY

Wild fish and their habitats must be protected and restored in order to maintain viable and healthy fisheries and to provide for associated ecological, cultural, and aesthetic values. To accomplish this objective, state and tribal fishery managers have committed to a wide range of activities. One of these, directed initially toward salmon and steelhead, was the Wild Stock Restoration Initiative (WSRI) designed to complement and strengthen ongoing programs to protect and restore healthy stocks and habitats. The managers' overall goal for the WSRI is to:

> **Maintain and restore healthy wild salmon and steelhead stocks and their habitats in order to support the region's fisheries, economies, and other societal values**.

Following formulation of the WSRI, a broad policy framework, the Wild Salmonid Policy (WSP) has been developed by state and tribal managers which encompasses **all wild salmonids** in Washington (WDFW 1997a).

The goal of the WSP is to:

> **Protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries, non-consumptive fish benefits, and other related cultural and ecological values.**

The policy guidelines and tasks reflected in both the WSRI and WSP will guide statewide efforts to maintain and restore coastal cutthroat. These tasks include:

- complete and maintain a resource status inventory of Washington's wild salmonids[2] ("where are we now")

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[2] While the inventory documented in this report reflects primarily an assessment of wild stock status, a clear need exists to develop complementary salmonid habitat and hatchery stock inventories to develop an integrated ability to systematically evaluate salmonid ecosystems. Work on a joint state/tribal habitat inventory is underway, and a hatchery inventory is planned.

- " identify stocks and determine their status
- " review and prioritize stock status problems
- " identify priority information needs

! review current resource management goals and objectives pertaining to hatchery and wild stocks and the region's fisheries ("where do we want to go")

! develop and implement recovery programs for priority stocks and habitats ("how do we get there")

! maintain adequate monitoring and evaluation programs ("how well did we do, and do we need to modify our approach")

Productive aquatic ecosystems are essential for healthy salmonid populations that provide an important foundation for a strong Northwest economy as well as for a diverse cultural and natural heritage. Managing for stock health and related human benefits requires maintaining adequate resource abundance, productive habitat, and genetically diverse wild stocks. The WDFW and Western Washington Treaty Indian tribes have jointly challenged themselves to create opportunities for a positive future that will feature productive aquatic habitats, healthy wild stocks, and adequate levels of fishing. Clearly, strong public support for solving complex problems will be necessary to realize this vision. The WSRI and WSP will provide additional focus and resources for the State's and tribes' current fishery resource management mandates. The initiative and policy are intended to produce comprehensive management approaches to restore depleted salmonid stocks and avoid intensely disruptive and divisive reactions that can result when the ESA listing process is invoked.

RESOURCE STATUS INVENTORY

This report is the second resource status inventory (the first objective in the statewide Wild Stock Restoration Initiative and consistent with the Wild Salmonid Policy) using SASSI approaches and conventions with some modifications. The name of the original inventory "Salmon and Steelhead Stock Inventory" (SASSI), was changed to **"Salmonid Stock Inventory" (SaSI)**, to reflect the broadened inventory scope encompassing all wild salmonids, first for bull trout and Dolly Varden (WDFW 1997b, 1998) and now for coastal cutthroat.

This coastal cutthroat inventory considers issues that did not need to be addressed for salmon and steelhead (e.g., difficulty of identifying individual stocks, multiple life history forms within stocks, limited available data). Therefore, in this inventory modifications to the SASSI approach have been made to better address issues pertinent to coastal cutthroat. These changes should lend themselves to future inventories for other wild salmonid species whose life history, ecology, and management histories are more similar to those of native char and coastal cutthroat than they are to salmon and steelhead.

The concept of resource inventories is not new - fishery management agencies spend considerable staff time collecting and assessing resource status data, e.g., spawning escapements, harvests, and biological parameters. This information is routinely used for decision making but often is not well documented or visible outside the "management process." As a result, an objective of SaSI has been to develop a simple and consistent system of collating and reporting statewide salmonid resource assessment information, recognizing that the inventory will change over time. This inventory incorporated information already available in existing documents and information recently compiled for submission to NMFS as part of ESA proceedings. Future updates of SaSI and associated reports will evolve as necessary to accommodate new information and be integrated with developing regional resource information systems. The planned growth and refinement for SaSI is an important point. This report is meant to provide a first glimpse at coastal cutthroat status and build a foundation for future restoration and inventory efforts.

In addition to understanding the inventory's intent, it is important to note that SaSI is <u>not</u>:

- a compendium of all that is known about each salmonid stock
- a historical review of past losses of stocks or habitats
- a detailed review of harvest management
- a habitat inventory
- a detailed review of the impacts of salmonid culture programs on the status of native stocks
- a risk assessment of future threats of extinction or other stock damage
- a report outlining specific stock restoration programs

Clearly these and other steps will be necessary and are anticipated to follow the inventory, but this SaSI report simply is intended to provide information on current status to provide a foundation for salmonid recovery. The subsequent steps and the process envisioned for the overall initiative are presented in <u>Part 3 -- Current and Future Actions</u>.

The status information in this report is based almost entirely on numerical abundance rather than interpretation of genetic fitness. This orientation is not intended to discount the importance of any stock's genetic status but reflects the need to perform genetic risk assessments throughout the state in a systematic manner. Many genetic impacts to the region's wild stocks have occurred over time from cumulative impacts of habitat degradation, harvest policies and hatchery practices. Biologists involved in the inventory have identified current or new genetic impact issues that may require priority attention. Stock origin (native, non-native and mixed) has been presented for each stock complex and discussions about potential genetic influences have been included where known.

Report Content and Organization

As in the 1992 SASSI and the 1997 and 1998 SaSI inventories for bull trout and Dolly Varden, this SaSI report is organized so that the reader proceeds from general discussions to more detailed information used in the process of identifying individual stocks and determining their status. Parts 1, 2, and 3 describe the inventory methodologies and provide a summary of stock status for the reader who may not desire to review the detailed stock status information presented in Part 4. The report is comprised of the following sections:

Part 1 -- Stock Definition and Identification: This section defines the terms stock and stock complex as used in this inventory, compares them with other stock definitions, and discusses their application in this inventory.

Part 2 -- Stock Assessment and Status: This section describes the data types used to assess stock status, and discusses the two-step process that was used to identify stocks that are at low abundance levels. A set of screening criteria, based on negative population trends or changes in fitness, were developed to assess the current status of each stock/stock complex. Individual stocks were then rated using five status categories developed for SASSI/SaSI.

Part 3 -- Current and Future Actions: This section describes the process envisioned for applying the inventory results to the objective of restoring priority stocks and addressing key information needs. This is followed by a description of the review process that will allow for future iterations of SaSI, making it a living inventory of Washington salmonids. The steps and process for developing cooperative state/tribal restoration plans for regions, watersheds or specific stocks are also outlined.

Part 4 -- Stock Reports: In this section, specific information on each coastal cutthroat stock currently identified is organized by river basin and consists of individual Stock Reports. Each Stock Report includes the following two sections:

! Narrative: This section discusses stock definition and origin, and status information. It also provides a brief discussion of habitat, harvest, hatchery and other factors that may be affecting production of each stock.

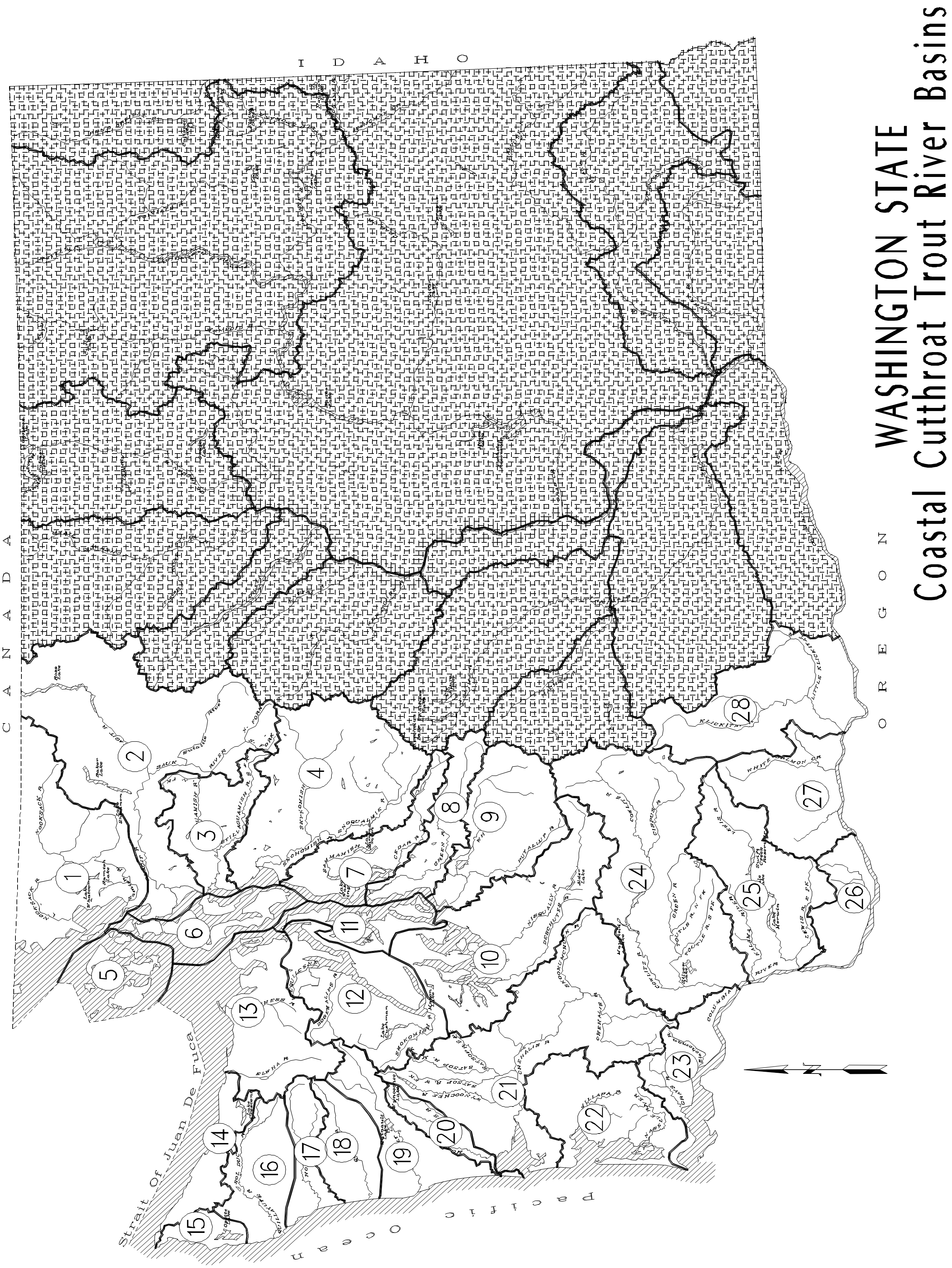
! Stock profiles: This is a visually oriented, two-page summary section that contains the information used to identify and rate the status of each stock. The amount of information included in the profiles provides a general reflection of the data and state of analysis available for any given stock.

The **Literature Cited** section presents a list of publications cited in this inventory volume.

The **Glossary** provides definitions of terms developed specifically for SASSI/SaSI and also defines a number of general terms used in the text.

SaSI RIVER BASINS

SaSI Stock Definition Profiles within each Stock Report display spawning distribution information for salmonid stocks in Washington on river basin maps. These maps are scaled not only to present spawner distributions, but must also fit the format of the profile pages. This sometimes makes it difficult to relate a specific river basin map to adjacent systems. To help orient the reader, the state map on the following page locates all the river basins used in SaSI. These SaSI river basins are similar to, but not the same as Water Resource Inventory Areas (WRIAs), which are used by Washington State natural resource agencies (Williams et al. 1975; Phinney and Bucknell 1975).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PUGET SOUND

North Puget Sound

1- Nooksack/Samish
2- Skagit
3- Stillaguamish
4- Snohomish
5- San Juan Islands
6- Whidbey

South Puget Sound

7- Lake Washington
8- Duwamish/Green
9- Puyallup
10- Nisqually/Deep South Sound
11- East Kitsap

Hood Canal/Strait of Juan de Fuca

12- Hood Canal
13- Elwha/Dungeness
14- West Strait

COASTAL WASHINGTON

North Coast

15- Sooes/Ozette
16- Quillayute
17- Hoh
18- Queets
19- Quinault

Grays Harbor

20- Humptulips
21- Chehalis

Willapa Bay

22- Willapa/Nemah/Naselle

COLUMBIA RIVER

Lower Columbia River

23- Grays/Elochoman
24- Cowlitz
25- Kalama/Lewis
26- Washougal
27- Wind/White Salmon
28- Klickitat

Note: Shaded area is not known to contain coastal cutthroat.

PART 1 -- STOCK DEFINITION AND IDENTIFICATION

STOCK DEFINITION

The first task in developing salmonid resource inventories has been to arrive at a meaningful definition of the units of fish on which to base the assessment. Stocks were chosen as the basis for SaSI for several reasons. They provide the finest resolution of all the units considered and allow assessment of larger units by combination. Stocks form the basic building blocks of Northwest salmonid management, and stock units are widely accepted within the scientific community as a basis for evaluating fish populations.

The definition of the term "stock" and its application frequently present difficulties because the distinctions between different groups of organisms are often difficult to measure, and because the term is used for a variety of purposes. For example, as applied in bottom fish management, a stock is a group of fish that exhibits a homogeneous response to fishing effort in an area, and may be made up of several breeding populations, or be part of a population. However, in salmonid management a stock is generally considered a discrete breeding population. Ricker (1972) defined salmon stocks as temporally or spatially separated breeding populations. The Puget Sound Salmon Management Plan refers to the fish of a single species that migrate at a particular season to a specific hatchery or independent river system as a stock.

At a stock identification workshop (April 1970) W.E. Ricker presented a paper discussing the origin of salmon stocks that used the following definition:

> "...the term *stock* is used here to describe the fish spawning in a particular lake or stream (or portion of it) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season. What constitutes a "substantial degree" is open to discussion and investigation, but I do not mean to exclude *all* exchange of genetic material between stocks, nor is this necessary in order to maintain distinctive stock characteristics that increase an individual's expectation of producing progeny in each local habitat.
>
> In some rivers a number of stocks can be grouped together on the basis of similarity of migration times. The word *run* will be used for such groupings. Thus we may speak of a fall run of chinook salmon or steelhead, for example. Each run may comprise a considerable number of stocks."

We have adopted the following definition for SaSI which is essentially the same as that proposed by Ricker.

> **<u>SaSI STOCK DEFINITION</u>: The fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.**

It should be noted that some differing views likely will surround any specific definition of stock. This inventory is not attempting to resolve these views or their applications. The purpose of the

SaSI definition is simply to provide a clear, consistent and meaningful basis for conducting an inventory of the salmonid resources in Washington, and does not imply that this definition should be applied for other uses, that even smaller units of production are unimportant, or that the management of fisheries or fish habitat should be on this basis. Where reproductive isolation has been shown or presumed to exist in this inventory, it may or may not indicate genetic uniqueness from other stocks. The terms stock and spawning population are used synonymously in this inventory.

Even with SaSI's basic stock definition, considerable uncertainty often occurs in applying it to any specific spawning group because limited direct data exist to evaluate the degree of reproductive isolation among such groups. Fish management entities have inventoried fish populations annually as an integral part of the management process. Data collection programs focus primarily on gathering information necessary to manage various salmonid fisheries. Consequently the detailed information needed to identify and evaluate Washington's wild stocks is often quite limited. This lack of detailed data has imposed some restrictions on the development and use of this inventory. It is impossible to ensure that SaSI accurately defines all wild salmonid stocks in the state. Many stocks listed in this inventory have not been studied in enough detail to be designated as discrete stocks with great certainty. Many others need more refined data to determine whether observed differences in timing or distribution actually represent stock differentiation. This inventory must be viewed as a starting point, and its list of stocks should be expected to evolve with future updates. The stock inventory process will continue to be conducted and, as more information is assembled, stocks will be added or deleted based on additional information.

Identifying individual coastal cutthroat stocks has so far proved to be far more challenging than for salmon, steelhead, or bull trout and Dolly Varden. This inventory volume therefore introduces the concept of the **Stock Complex**.

> **<u>SaSI STOCK COMPLEX DEFINITION</u>**: **A group of stocks typically located within a single watershed or other relatively limited geographic area and believed to be closely related to one another.**

The concept of stock complexes was developed in response to genetic analyses (Campton 1981, Campton and Utter 1985, Zimmerman 1995, Williams et al. 1997) which indicated that there is a high degree of genetic diversity among coastal cutthroat populations. In most cases, individual collections of coastal cutthroat are significantly different from one another, even within rather small stream systems (Zimmerman 1995). WDFW biologists concluded at an early stage of coastal cutthroat stock identification that it is difficult to identify individual stocks, particularly in large river systems, with any confidence. This is especially true given the uncertainty about genetic relations among the different life history forms. Consequently stock complexes were identified based on geographic distribution of spawning grounds (as was done for stocks in other salmonid stock inventories). Each complex therefore includes all life forms, and no attempt is made to separate the anadromous, fluvial, adfluvial, and resident components. Numbers of individual stocks within stock complexes are currently unknown, and it may never be possible to identify all stocks within a complex in any but the smallest watersheds or groups of adjacent watersheds.

In this inventory, stock complexes are treated in much the same way as stocks in other SaSI volumes. Stock complexes were identified using the same criteria as stocks. Abundance and survival data were collected and analyzed as they were for stocks, status determinations were assessed in the same way as for stocks, and reports were written for stock complexes using the same format used for stock reports.

The SaSI reports have emphasized **naturally-reproducing** stocks of salmonids regardless of origin (native, non-native and mixed parentage). Future reports will include hatchery stocks as well. Only those stocks that spawn within Washington State are included. Past extinctions have not been included in this status assessment because this is a **current** resource inventory, and the historic information on lost stocks is incomplete and often anecdotal. Where reliable information is available, reference may be made to extinctions in general terms in introductory sections only.

SaSI tends to focus on differences among stocks rather than variability within each stock. However, managing salmonid stocks to maintain historical patterns of genetic variability within spawning populations, as well as genetic diversity among populations, is necessary for the long-term fitness and productivity of each species. This variability and diversity determines the ability of stocks and species to adapt to and successfully reproduce under changing environmental conditions. Resource management practices must address the need to maintain both genetic diversity between stocks and genetic variability within stocks. Species-specific genetic guidelines will need to be developed in the context of species plans, consistent with genetic conservation goals of the WSP.

STOCK DEFINITION CRITERIA

Although individual coastal cutthroat stock complexes, rather than stocks, have been identified in this inventory volume, criteria used to identify both hierachical structures are similar. These criteria are not intended to determine stock origin (i. e., native, non-native or mixed parentage), but rather to identify those groups that appear to represent distinct stocks.

Stock Definition Criteria

1) **Distinct spawning distribution.**

2) **Distinct temporal distribution (including spawning or run-timing).**

3) **Distinct biological characteristics (e.g. size, age structure, gene frequency differences, etc.)**

Each of these criteria is an attribute that can be used to determine whether a group of fish is displaying substantial reproductive isolation. A population meeting any one of the above criteria would be initially classified as a SaSI stock until additional information shows that it should not be considered distinct. The term *distinct* is not intended to imply complete isolation from other stocks. We recognize that some interchange between populations is a natural part of salmonid biology.

Distinct spawning distribution is the most commonly used criterion for identifying individual stocks in the SaSI reports because general information on the geographic location of spawning and spawning habitat is the most readily available. However, spawning distribution often does not show distinct separation and can be difficult to assess. A number of factors must be considered such as: degree of isolation, interchange between spawning groups, and the relationships between spawners in adjacent streams. It is also difficult to measure directly because it requires that spawning distribution of several generations of fish be tracked (i.e., do offspring of each generation return to spawn in the same areas that are substantially separated from areas used by other spawning groups). This criterion must usually be assumed since empirical data are often unavailable and are difficult to collect. In the case of coastal cutthroat trout, this criterion was the primary one used to identify stock complexes.

Distinct temporal distribution identifies stock differences based on variations in timing of critical life stages (e.g. spawn timing). Such differences are sometimes very distinct with no overlap between adjacent stocks. Differences are then generally quite obvious and easy to assess from readily-collected information. Many cases occur, however, where timing does overlap, and the difference between within-stock variation and variation among stocks becomes less clear.

Distinct biological characteristics can include any observable distinctions between stocks in size, color, age structure, scale patterns, parasites, or gene frequencies.

There is a hierarchy of stock relationships within a species, from individual spawning aggregations within stocks (the finest scale) up to the entire species (the broadest scale). Moving up from the level of individual stocks/stock complexes, WDFW defines **Genetic Diversity Units (GDUs)** as groups of stocks having similar patterns in genetic (or other) characteristics, which have resulted to an important extent from reproductive isolation (WDFW 1995). GDUs form an important focus for genetic conservation goals and objectives of the WSP. In addition, WDFW has combined GDUs into still larger groups, **Major Ancestral Lineages (MALs)** which are reproductively isolated groups of GDUs with a probable distant common ancestor (WDFW 1995).

NMFS (Waples 1991) has incorporated reproductive isolation of breeding populations in its ESA "species" definition but departs from the standard stock definition by requiring a spawning group or groups to represent an evolutionarily significant unit (ESU) of the species. Genetic relationships and evolutionary legacies among stocks, which are central to the species definition used by NMFS under ESA, are second-stage questions not directly bearing on the need by fish managers to define stocks for an ongoing inventory program. SaSI stocks, GDUs and MALs have been defined independently of NMFS' evolutionarily significant units.

GENETIC ANALYSIS

For initial genetic analysis of Washington coastal cutthroat, tissue samples for allozyme electrophoresis (see Genetic Stock Identification section below). A total of 47 collections was made from seven broadly defined geographic regions (North Puget Sound, South Puget Sound, Hood Canal, Strait of Juan de Fuca, North and South Washington coast and Lower Columbia River tributaries). Allozyme data were analyzed by laboratories at WDFW and NMFS. A subset of thirteen WDFW collections was also analyzed for variation at six microsatellite DNA loci by John Wenburg at the University of Washington. Results of the allozyme and microsatellite DNA analyses are presented in individual stock reports. More detailed information about these analyses will be presented in the coastal cutthroat volume (in preparation) of the WDFW Genetic Diversity Units and the Major Ancestral Lineages of Salmonid Fishes in Washington report series.

A preliminary analysis was conducted to identify coastal cutthroat and steelhead hybrids. A total of eight allozyme loci were used to identify individuals as either steelhead, cutthroat or hybrids. Fish exhibiting at least 50% of diagnostic loci as homozygous for steelhead alleles or heterozygous for steelhead and cutthroat alleles were considered to be hybrids. Those individuals identified as steelhead or hybrids were removed from the data set.

High levels of genetic variation were found among sample collections, even within regions. However, genetic analysis also showed that sample collections from a particular region tended to be more similar to one another than to those from other regions of the state. On a broader state-wide scale, the analysis supported the suggestion by Wenburg et al. (1998) that there are two large groupings of coastal cutthroat populations within Washington - an outer coastal and lower Columbia River group and an inner Puget Sound group. The dendrogram on page 28 illustrates relations among all WDFW coastal cutthroat sample collections sampled by WDFW.

Genetic Stock Identification

In SaSI, distinct biological characteristics can include any observable distinctions between stocks such as size or age structure, and for many salmonids, including coastal cutthroat, genetic characteristics which are revealed by **Genetic Stock Identification** (GSI). GSI is a method that can be used to characterize populations of organisms based on the genetic profiles of individuals. The methodology relies on the combined use of biochemical, genetic, and statistical procedures to characterize and discriminate stocks (see below for descriptions of these procedures).

Although the GSI characterization of stocks and testing of stock structure provide a direct measure of genetic relationships, it is important to be aware of the limitations of this approach. It is presently possible to investigate only a tiny and restricted fraction of the genetic traits of salmonids by biochemical means. To the extent that the characters that can be investigated do not represent the entire genome, the view of genetic relationships derived from GSI analysis will be incomplete (and could fail to detect evidence of reproductive isolation among stocks--see below). Indeed, there is a large number of genetically-influenced characteristics of salmonids about which there is little or no information. It is assumed that most or all of the genetic variation which can be studied using biochemical means is not subjected to natural selection, that is, it is selectively neutral. While this assumption seems justified given much of population genetics theory and a considerable amount of empirical data from a large number of organisms, exceptions could complicate or even invalidate some of our interpretations. It must also be realized that statistical tests (e.g. G-test) of stock structure can be reasonably used to establish the existence of multiple stocks but not to disprove that multiple stocks exist. While statistically significant differences among samples provide strong evidence for the existence of distinct gene pools (i.e. separate stocks), the absence of significant differences does **not** constitute proof that only a single stock exists.

The following description of the GSI applies to investigations of enzyme variants (allozymes) but not to direct examination of DNA variants. As currently applied to the investigation of coastal cutthroat, the GSI process consists of a series of steps: (1) collect selected tissues (usually muscle, heart, eye and liver) from a representative sample of individuals (usually 100 or more) from the population(s) under investigation, (2) develop genetic profiles (at 15 or more variable loci) for the individuals in each population by conducting starch-gel electrophoresis and biochemical staining of tissue extracts, (3) characterize each population sampled by aggregating the individual genetic profiles and computing allele frequency distributions for each population, and (4) conduct statistical tests (G-test or chi-square) on the allele frequencies characterizing each population.

Electrophoresis is a process whereby charged molecules (such as enzymes from tissue samples) are separated in an electric field in slab of gel-like material. The distance which molecule moves through an electric field applied to the gel (its electrophoretic mobility) is a biochemical phenotype determined largely by the genotype (DNA) of the fish from which the tissue samples were taken. After electrophoresis, enzymes can be visualized by biochemical staining. On staining, enzymes appear as colored bands in the gel, and the distance they moved during electrophoresis can be measured. Each enzyme (or enzyme subunit) is encoded by specific segment of DNA - a gene locus - which specifies its structure and electrophoretic mobility. Variation in the gene locus encoding an enzyme within a population produces two or more alternate forms of the locus called alleles. Much (but not all) of the allelic variation in enzyme-encoding gene loci can be detected by electrophoresis and staining because it results in structural and therefore electrophoretic mobility changes to the enzymes.

Reproductively isolated populations usually develop significant differences in allele frequencies at one or more loci over time. The power of GSI to identify and characterize stocks is derived from the differential distribution of allele frequencies at many gene loci in different stocks.

The hypothesis being tested in step 4 above (that the allele-frequency distributions of the populations being compared are no more different from one another than multiple independent samples from a single, freely interbreeding population would be) is closely tied to the definition of stocks as reproductively isolated populations. A statistically significant result in this test causes rejection of this hypothesis and typically leads to the conclusion that the populations tested are genetically different and, therefore, represent distinct stocks. The power of the statistical tests is dependent on the numbers of fish in the samples being compared. As a result, differences in allele frequencies that are not significant at small sample sizes can become significant if sample sizes are large enough.

Typically, the genetic testing of stock structure begins with G-tests (or chi-square tests) involving pairs of population sample collections. When the tests reveal significant differences, this is usually considered to be evidence for the existence of two genetically distinct stocks. However, in some cases individual sample collections are combined during the testing process. This is usually done when there are two or more separate collections from the same locality (usually taken in different years). The individual collections are combined in such cases because it is believed that the combination provides a better characterization of the population than does any single sample collection. Sample collections may also be combined from adjacent localities after testing of the separate collections has revealed no significant differentiation among them. For example, if six separate sample collections of Skagit River coastal cutthroat are collected from different localities (and possibly in different years) and no evidence of significant differences among them is found, they may be combined to characterize coastal cutthroat in the entire river system and this aggregate subsequently tested against collections or similar aggregates from nearby drainages.

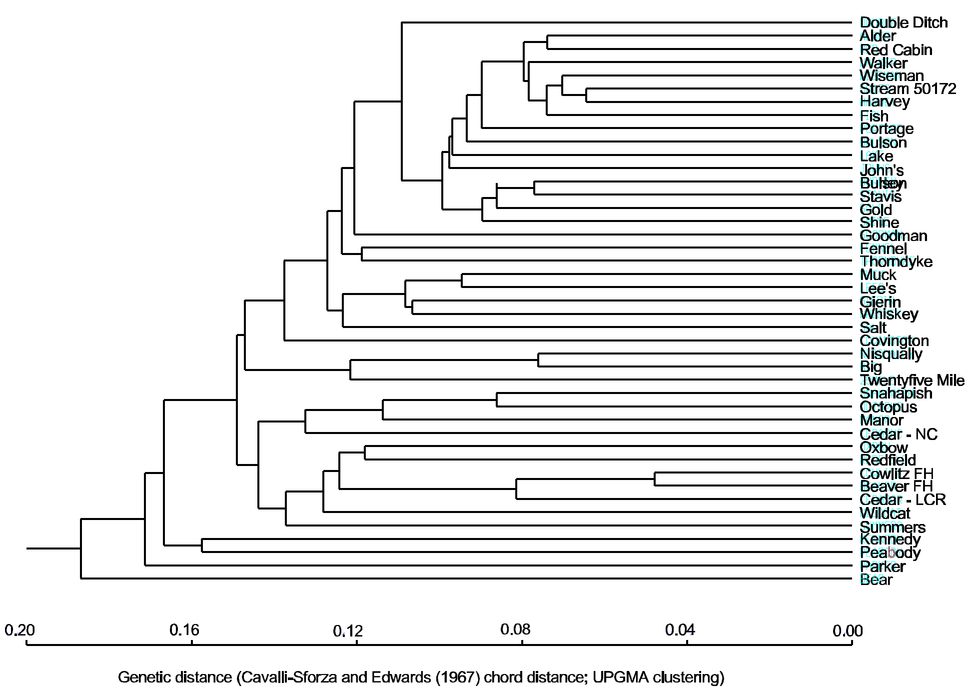
In addition to the direct testing of stock structure using the G-test approach, dendrograms based on the average genetic distances among sample collections have been used to summarize the genetic relationships among stocks. This commonly used approach provides a simple one-dimensional graphical representation of overall stock similarities and differences. The lengths of the horizontal branches that connect stocks in dendrograms are proportional to the average genetic distances between the stocks. The vertical position of individual stocks in a dendrogram does not necessarily reflect genetic relationships because each branch point is actually a point around which the lower level branches can be rotated without distorting the estimated genetic distances between them and the other stocks in the dendrogram.

While dendrograms are useful because they simplify the often complex patterns of genetic relationships among stocks, they are not without disadvantages. The absolute magnitude of differences identified by this technique is influenced both by the specific suite of gene loci included in the analysis and the particular genetic distance measure used. As individual stocks that are most similar are connected in the process of building the dendrogram, their relationships to other stocks can be distorted. The dendrogram analysis is **not** a test of stock structure, in part because it is independent of sample size. Thus, while dendrograms can be useful for depicting genetic relationships among stocks and for summarizing among-stock diversity, they cannot be used to define or identify distinct stocks genetically. This must be done using the results of the direct statistical tests (e.g. G-tests).

In WDFW coastal cutthroat genetic sampling, there has not yet been an attempt to compare fish located above and below barriers, or to compare different life history forms within stream systems.

<u>**Analysis of Genetic Information**</u>

Preliminary analysis of allozymes and microsatellite DNA (Wenberg et al. 1998) indicates that most Washington coastal cutthroat collections are genetically distinct from one another. There is a separation between the coastal/lower Columbia group and Strait of Juan de Fuca/Puget Sound. Within these two divisions, other genetic groupings are apparent, which coincide, for the most part, with geographical regions. However, there are a few outliers including the Muck Creek (Nisqually River) collection, which groups with Strait of Juan de Fuca collections, and collections from several South Puget Sound tributaries that were particularly divergent. Whether these outliers reflect possible differences in life history forms, hybridization, sampling error, or are the result of some unknown variable, is not known at this time.



THE STOCK COMPLEX IDENTIFICATION PROCESS

The list of coastal cutthroat stock complexes in this SaSI document represents an effort to identify all existing populations that naturally reproduce in Washington waters, regardless of origin, including native and mixed (or presumed hybrid) stocks.

Because of the significant uncertainties regarding the life history, genetic, and evolutionary relationships among life history types in local areas, fish from adjacent areas with common habitat characteristics were generally aggregated into a single stock complex (e.g. East Hood Canal) because of the likelihood of significant interchange of spawners. Additional information on genetics, life histories and ecological relations will be incorporated into future iterations of SaSI as it becomes available. Again, it should be noted that life-history form differences were not used to separate stocks, or populations. Future drafts may support life-history form separations based on genetic information.

To arrive at a preliminary list of stock complexes, biologists used known differences in spatial or temporal distribution. These distinctions were difficult to determine in some cases, particularly where the amount of interchange among adjacent groups of fish was unknown. Identification of individual stock complexes was based primarily on river basins in which spawning is known to occur. This preliminary list of stock complexes was then examined using available information on unique biological characteristics (principally genetic stock identification data). This review confirmed the hypothesis that the number of individual coastal cutthroat stocks may be very large and that identification of stock complexes is appropriate as a first step in understanding coastal cutthroat population structure. More detailed analysis during future inventories may change this approach.

This inventory has identified 40 coastal cutthroat stock complexes statewide, and Table 1 presents a regional summary. Individual regional lists for Puget Sound, Coastal, and Columbia River stocks are provided at the end of Part 2 - Stock Assessment and Status (Tables 3, 4 and 5).

Table 1. Regional and statewide coastal cutthroat stocks/stock complexes.

PUGET SOUND	
North Puget Sound	8
South Puget Sound	4
Hood Canal	2
Strait of Juan de Fuca	3
TOTAL	17
COASTAL	
North Coast	6
Grays Harbor	2
Willapa Bay	4
TOTAL	12
COLUMBIA RIVER	
Lower Columbia	11
TOTAL	11
WASHINGTON STATE TOTAL	40

Stock Origin

Regardless of species, the SaSI process recognizes three categories of stock origin: (1) stocks of fish that are thought to represent native gene pools, (2) stocks that have resulted from the introductions of non-native fish, and (3) stocks that are a mix of native and non-native fish, or are substantially genetically altered native fish. A great deal of uncertainty often exists about the genetic histories of many salmon and steelhead stocks (WDF et al. 1993). The contributions of hatchery-origin coastal cutthroat to native Washington populations have not been rigorously evaluated. However, because of the relatively limited number of cutthroat trout hatchery programs, most Washington coastal cutthroat stock complexes have been characterized as native in origin. In addition to identifying stock complexes which include contributions from non-native hatchery stocks, coastal cutthroat sometimes show evidence of having hybridized with steelhead.

The definitions for stock origin used in SaSI are:

Native -- An indigenous stock of fish that has not been substantially impacted by genetic interactions with non-native stocks and is still present in all or part of its original range. In limited cases, a native stock may also exist outside of its original habitat (e.g., captive brood stock programs).

Non-native -- A stock that has become established outside of its original range.

Mixed -- A stock whose individuals originated from commingled native and non-native parents, and/or by mating between native and non-native fish (hybridization); or a previously native stock that has undergone substantial genetic alteration. This may include species crosses such as hybrids between cutthroat and steelhead, or rainbow trout.

Unknown -- This description is applied to stocks where there is insufficient information to identify stock origin with confidence.

Production Type

This inventory attempts to describe the naturally-reproducing coastal cutthroat in the state. The origin of a stock or stock complex refers only to the genetic background of that specific group of fish. To understand more about the nature of an individual stock or stock complex, it is also necessary to describe the type of spawning and rearing that produced the fish. For example, a stock of fish may be a genetic mixture of native and non-native fish, but in the absence of continuing hatchery releases, the stock may be self-sustaining as the result of natural spawning and rearing. These fish would be identified as a stock with a mixed origin and a wild production type. A native stock of fish in a rehabilitation program also can be sustained entirely by fish culture techniques. This situation is typified by Baker River sockeye salmon, a stock that is currently being restored by placing most spawners in an artificial spawning beach. This stock would be characterized as a native stock with a cultured production type. Some stocks may be maintained by both wild and cultured spawning and rearing. For example, the Washougal coastal cutthroat stock complex includes both native fish spawning in the wild and native fish which were taken into the Skamania Hatchery as broodstock. This stock complex is considered native with composite production.

The terms defining production type are:

Wild -- A stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage (includes native).

Cultured -- A stock that depends upon spawning, incubation, hatching, or rearing in a hatchery or other artificial production facility.

Composite -- A stock sustained by both wild and artificial production.

Tables 3, 4, and 5 (Part 2 - Stock Assessment and Status) present the origin and production type for each coastal cutthroat stock complex in this inventory. There are relatively fewer composite coastal cutthroat stock complexes than are seen in salmon and steelhead which reflects differences in management approaches and hatchery practices for different species.

OTHER STOCK INVENTORIES

For many fish species, stock inventories are a normal part of the annual state/tribal management process in Washington State. These inventories take the form of annual assessments of various abundance attributes and are used to measure the effectiveness of management actions. SaSI differs from these routine assessments because it looks at smaller units of production, brings this information together in a consistent approach for all wild salmonid stocks statewide, and provides a system for rating stock status. As with other SaSI volumes, information in this inventory is presented by geographic region.

Other examples of regional inventories including other species are the Puget Sound and Adjacent Waters Study - Appendix XI - Fish and Wildlife Appendix (Pacific Northwest River Basin Commission 1970) which was a combined effort of WDG and WDF. In the Columbia River basin examples include Stock Assessment of Columbia River Salmonids (Howell et al. 1985) and the sub-basin plans for each tributary. More recent efforts listed anadromous salmonid stocks at risk of extinction (Nehlsen et al. 1991), while Huntington et al. (1994) listed stocks deemed to be healthiest.

PART 2 -- STOCK ASSESSMENT AND STATUS

Once the stock complexes were identified, the current status of each was assessed based primarily on trends in population size, spawner abundance, or survival. Where possible, age structure, size (body length), survival, and other data have also been used in these determinations. Detailed abundance data for individual stock complexes were frequently non-existent.

A two-step process was used to evaluate the status of the state's coastal cutthroat stock complexes. First, each stock complex was screened to identify negative changes in abundance, production or survival using five separate criteria that were originally developed to describe changes in stock status and fitness for SASSI (Washington Department of Fisheries et al. 1993). For a description of these criteria see the Stock Screening discussion below. Stock complexes that met none of the five criteria and were judged to be experiencing production levels within natural variations in survival and consistent with their available habitat were rated as "Healthy." Second, any stock complex that met one or more of the five negative performance criteria was examined further and subsequently rated in Depressed or Critical status categories to identify the probable level of damage suffered by the stock. An "Unknown" category was used for stock complexes if trend information was unavailable or was insufficient to assess status. The assessment data used for stock complex screening and the rationales for stock complex categorizations are presented in Part 4 -- Stock Reports.

There are several circumstances that complicated the rating process. When a wild stock experiences an extremely low survival, it is sometimes difficult to know if that survival is within the normal range for the stock, or if it is entering a depressed state caused by human impacts (e.g., habitat destruction or over-fishing). Naturally-produced salmonid stocks exhibit wide variations in survival, caused in part by changes in freshwater stream flows (droughts and flooding), ocean conditions (e.g., El Niño events) and biological interactions such as competition and predation (Cooper and Johnson 1992). It is not uncommon for wild stocks to experience one or two extremely low survival years each decade, resulting in low adult returns. This type of natural variation also provides years of above average production.

Some stocks are experiencing survivals that are so low that they are clearly below the level of natural variation. The survivals of other stocks are intermediate between obviously healthy stocks and clearly depressed stocks and are the most challenging to evaluate because they could be experiencing low survivals within the normal range for the stock. Short-term databases often exacerbate the rating problem because with only a few years of observation it is unlikely that the lowest natural survivals have been documented. The evaluation of stocks with intermediate survivals was based on the collective judgment of technical agency staff members most familiar with each stock.

The possibility of cycling in the survival rates of various stocks also can create difficulty in rating stock status. These cycles may be associated with weather-related impacts on fresh water spawning and rearing success. The apparent existence of cycles in survival and production data complicates the task of identifying depleted stocks, since poor stock performance could be the result of natural cyclic variation. Wherever possible, the existence of survival cycles was considered during the stock evaluation process and stocks with production levels within normal ranges of variation (including cyclic variation) were rated healthy.

STOCK SCREENING

The best available escapement, population size, and survival data were used to screen each coastal cutthroat stock complex for indications of negative production or survival trends. Only stock complex-specific data were used, which sometimes limited the available data to a short span of recent years. These data were plotted and qualitatively examined for changes in abundance or survival. Often, only a single type of data was available to analyze the production trend of a stock complex. When multiple types of data could be used to examine individual stock complex status, the available production or survival data sets were examined individually, and each stock complex's rating was based on the data that best described current status.

The five stock screening criteria initially developed for SASSI were used in the preliminary evaluation of each stock complex for trends in survival, escapement, or production. These criteria do not currently incorporate quantitative formulas because the available stock-complex-specific information was often too limited for statistical evaluation. More subjective criteria were applied, and decisions were based on the collective judgment of the technical reviewers most familiar with each stock complex. While this approach likely can be improved in the future with additional and better information, it facilitated this initial stock complex status classification process. The status of each stock complex will be subject to ongoing review and refinement in subsequent inventories.

The five stock screening criteria are:

(1) Long-Term Negative Trend -- This criterion reflects at least ten years of data showing a consistent drop in a survival or production parameter. The negative trend is the important factor, and several high values would not eliminate a stock complex from being categorized under this criterion. Although most Washington salmon and steelhead escapement and production data bases span periods of ten to twenty-five years, such data time series are currently seldom available for coastal cutthroat.

(2) Short-Term Severe Decline -- A short-term drop in escapement or production is often difficult to distinguish from the amount of natural variation displayed by all naturally produced stocks. It is important, however, to attempt to identify declining stock complexes as early as possible, so that limiting factors can be recognized and, if possible, corrected before serious damage occurs. The most recent five years of production data were examined for evidence of any significant drop in escapement, population size, or survival. If two of the five years display significant production decreases, the stock complex is included in this category.

(3) Chronically Low -- Stock complexes in this category are sustaining themselves at levels significantly below their potential. The determination that a stock complex is chronically low may be based on observed past production levels, or on an assessment that stock complex performance does not meet expected levels based on available habitat. Chronically low stock complexes may display declining, stable, or even increasing trends. For stock complexes that have displayed chronically low production for an extended period, it may be necessary to examine any available data for the years before current stock assessment databases were developed.

(4) Decreases In Fitness -- The ability of wild salmonid stock complexes to sustain themselves can be significantly affected by changes in the fitness of the individuals that make up a given stock complex. These changes can be subtle and include factors like changes in adult size or age structure, inbreeding associated with small numbers of spawners, changes in spawn timing, or other reduction in genetic variability. Any significant changes in fitness may justify the inclusion of a stock in this category. Currently no information is included in this inventory that allows any quantitative assessment of change in fitness. We intend to include data on age structure, size, sex ratios, and other life history characteristics in future updates to allow fitness evaluations.

(5) Unknown -- Many coastal cutthroat stock complexes have not been monitored or enumerated over a sufficient period of years to enable quantitative analysis of status. Stock complexes in this category will have an Unknown status rating. Determination of their status for future inventories will require more intensive stock assessment work.

STOCK ASSESSMENT DATA TYPES

As stated earlier, evaluations of the current status of coastal cutthroat use the best available quantitative information on stock complex abundance, harvest, and survival and consider the four primary life history types (anadromous, fluvial, adfluvial, resident) both individually and in the composite. The data types used are consistent with those used in the 1992 SASSI report and 1997 and 1998 SaSI bull trout and Dolly Varden reports. Since available data are more limited for coastal cutthroat than for salmon and steelhead, fewer data types are used in this inventory. Stock assessment data will be presented in individual reports for each stock complex (see Part 4 -- Stock Reports). Outlined below are stock assessment data types and terms used for this coastal cutthroat inventory. It is important to note that the data types described below are not intended to be all inclusive, but contain those used in this inventory and others with general relevance although they may not appear in this inventory.

Size of Spawning Population/Escapement

For coastal cutthroat, the term escapement refers to mature fish that have returned to fresh water, have survived all fisheries, and constitute the spawning population of a given stock. Escapement data collected during spawning ground surveys are sources of information that may allow direct enumeration of escapement. Counts made at traps and fish passage facilities may be of use. For most coastal cutthroat stock complexes, direct escapements are not estimated, and indirect measures are needed to assess stock status. Indirect escapement information would include counts of spawners in index areas or other measures, preferably collected on an annual basis. Indirect counts do not provide total escapements but instead provide relative data that can be used to determine changes in abundance and long-term trends. Other indirect measures include age-size frequency, proportion of sexually mature fish vs. age, frequency of repeat spawning, percent use of available habitat over time (years).

The following escapement data sets were modified from the 1992 SASSI report for application to coastal cutthroat stock complexes and bull trout and Dolly Varden stocks (WDFW 1997b, 1998).

ESCAPEMENT

Index total	An estimate of total escapement in an index area.
Peak count	The highest daily count of live fish in an index area.
Fish/mile	A spawner count divided by the number of miles surveyed.
Redds	A count of redds in an index area.
Redds/mile	A redd count divided by the number of miles surveyed.
Rack count	A total count of fish destined for spawning grounds upstream of a rack.
Snorkel index	A count of adults observed while snorkeling an index area.
Trap count	A total count of fish destined for spawning areas upstream of a fish trapping facility.
Total	An estimate of all fish of a stock that have survived all fisheries and make up a spawning population.

Harvest Data

The numbers of fish caught or harvested in various fisheries can be used to measure relative abundance and to observe long-term trends. Most of the harvest data used in this inventory apply to the anadromous life history form. Since coastal cutthroat are not the target of commercial fisheries and are not often caught incidentally in nets, harvest data come exclusively from sport fisheries.

HARVEST

Sport	The total catches in a single sport fishery or the combined catches in all sport fisheries in a specific area.

Total Population/Run Size Data

The term total population size may pertain either to anadromous or non-anadromous life history types and refers to the total number of fish enumerated at a particular point in time. Run size pertains primarily to the anadromous form, and refers to the total number of fish enumerated at a particular point in their migration, e.g., total numbers of upstream migrants entering a watershed. These estimates may not include all returning fish, but they are believed to be adequate to represent the relative abundance of the anadromous stock component.

POPULATION/RUN SIZE

Total	The combined abundance/escapement and catch/harvest of a stock of fish in a specific area, but may not include all of the catches made everywhere for a specific stock.
Trap count	A total count of fish destined for areas upstream of a fish trapping facility.

Fresh Water Production Data

Counts of coastal cutthroat at various life stages in fresh water may be used to measure relative abundance and evaluate trends. These data are most commonly collected during fresh water incubation, rearing, or migration periods, and may include any life stage from egg to smolt (anadromous) or repeat spawner (anadromous and non-anadromous). These data would also be used to measure a variety of survival rates. However, because of inconsistencies in data collection methods, sampling locations, and time series, these data may often be of minimal value in quantifying abundance. They may be however, of considerable utility in assessing presence-absence and distribution. As a potential measure of presence-absence, this data category may include the percentage of available habitat use over time (years).

Fresh water PRODUCTION

No./100m^2 The average number of juveniles (of various age classes) produced per 100 square meters of habitat.

No./m^2 The average number of juveniles (of various age classes) produced per square meter of habitat.

Adult snorkel count The number of adults seen in snorkel surveys.

Snorkel The number of fish seen during snorkel surveys, usually juveniles.

Fish/hour The number of fish sampled by hook and line or seine gear divided by the number of hours of sampling.

Fish/day The number of fish sampled by hook and line or seine gear divided by the number of days of sampling.

Index total The total number of fish of all age classes sampled within an index area.

Total The total number of fish of all age classes sampled by hook and line or seine gear.

% Habitat Use Percentage of coastal cutthroat present in available habitat over time (years); can use index areas/counts.

Survival Data

The survival of fish of a given brood year can be expressed as a ratio between any two life stages, and when collected over a number of years can provide an indication of the success of specific stocks. Recruits per spawner is the most commonly used survival statistic for anadromous fish because it expresses the offspring total survival for a given parent year of spawning. However, it is difficult to apply this statistic without related information on abundance or density. This statistic may be of use in assessing the non-anadromous life history component, but more likely alternate statistics will be applied. These statistics may include data and trends in attributes such as size and age composition. Again, as was the case for fresh water production information, although these data may be of minimal value in quantifying stock abundance, they may be useful where density effects and harvest relationships are defined.

SURVIVAL

Rec/spawn — The number of adults (recruits) divided by the number of spawners from a brood year.

Age class — The percentage of a given age class surviving from one year to the next (based on size frequency and/or scale analysis data).

Age comp — Age structure of a population, including age at sexual maturity; and percentage of first, second, etc. time female spawners.

% > 12" — Percent of fish sampled which measured over 12 inches in total length. This category generally includes females which are old enough to be sexually mature.

% > 14" — Percent of fish sampled which measured over 14 inches in total length. This category generally includes females which are old enough to have spawned once.

Juvenile Data

Counts of juvenile salmonids at various life stages are used to measure relative abundance and evaluate trends. These count data are most commonly collected during the fresh water incubation, rearing, or migration periods, and may include any life stage from egg to smolt. Juvenile count data are used to measure a variety of survival rates.

JUVENILE

Smolts — The number of smolts produced by spawners from a brood year.

No Data

For most coastal cutthroat stock complexes, quantitative data does not exist to determine stock status using the rating criteria in this inventory. The status of these stock complexes would be rated as Unknown.

STOCK STATUS RATING

The stock-screening process is used to place stock complexes into five status categories. Stock complexes with escapement, population size or survival levels within normal ranges were rated as **Healthy**. Those stock complexes that currently display low production or survival values were assigned to one of two separate rating categories: **Depressed** or **Critical**, depending on the current condition of the stock complex. Stock complexes were also rated as **Unknown** when data limitations did not allow assessment of current status. A rating category for **Extinct** stock complexes was also included, although no extinct stock complexes have been identified. Definitions and discussions of each of these rating categories are provided below, along with the number of stock complexes assigned to each category.

The rating of stock complex status was done during a technical review process. The amount and quality of stock data vary among regions within the state, which can result in some differences in the application of the rating categories. These ratings represent the collective judgment of the technical staff most familiar with the individual complexes. The iterative nature of the inventory process will allow these ratings to be changed in the future as more detailed information becomes available, or because of changes in stock complex status.

Healthy Stock Complexes

> **Healthy -- A stock complex of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock complex.**

Healthy stock complexes are those currently experiencing stable escapement, survival, and production trends and not displaying a pattern of chronically low abundance. Because wild salmonid stocks experience large natural variations in survival (caused by environmental variations), it is not unusual for even the most robust stock to experience occasional low abundance or even fail to meet escapement goals. Such fluctuations would not necessarily warrant a change in status unless the stock experiences a consistent declining trend, or a sudden significant drop in production. The Healthy category covers a wide range of stock performance levels, from consistently robust production to those stocks that may be maintaining sustainable levels without providing any surplus production for directed harvests. In other words, the fact that a stock complex may be classified as Healthy in the inventory process does not necessarily mean that managers have no current concerns about its production status. State and tribal fishery managers believe very strongly that habitat protection and restoration needs exist for many of the stocks/stock complexes classified as Healthy in SaSI as well as for Critical and Depressed stocks/stock complexes. In addition, due to a lack of information on changes in fitness, some stock complexes were classified as Healthy that may have been significantly influenced by interactions with non-native species.

Considering habitat degradation, or loss, in assessing the status of individual stocks presents a particularly difficult problem. It is probable that all wild salmonid stocks in Washington have been affected by some level of habitat loss. It might be argued that if a stock has suffered any habitat loss, it cannot be judged to be Healthy. Such an argument is unrealistic, but it would still be desirable to identify some level at which the cumulative impacts of habitat loss have taken a stock out of the Healthy category. Unfortunately, it is difficult to accomplish this task, because individual stocks are faced with such a wide range of different habitat impacts. The SaSI report rates the **current status** of each stock based primarily on trends in survival rates and population size, and does not focus directly on causative factors. Habitat loss, over-fishing, or other factors, may be the reason that a stock is Depressed or Critical, but the rating is based on actual stock or stock complex performance.

The consideration of available habitat is included in the stock rating definitions for Healthy and Depressed stocks/stock complexes. This approach is an effort to recognize that there have been irreversible losses of habitat and that if stock/stock complex status were rated against a pristine habitat base, virtually every stock/stock complex could be rated depressed or worse. Such a result would be of little help in addressing the current need to restore our wild salmonid stocks. To provide a meaningful assessment of current stock/stock complex status, a flexible definition of "available" habitat is needed. In SaSI, "available" habitat may be habitat that is currently accessible to wild salmonids or in some cases may include all habitat that salmonids could reasonably be expected to utilize, even if currently inaccessible. For example, if a stock complex lost access to and/or was blocked from utilizing a substantial proportion of the available habitat in a stream, this may have been considered in the rating of stock complex status.

The definition of a Healthy stock complex is not meant to imply that a stock complex rating will remain healthy in the face of continuing habitat loss, even if the stock complex remains in balance with declining habitat. Future inventories will identify those Healthy stock complexes that are in need of attention to help ensure they remain at healthy levels. SaSI will also serve as a baseline against which any future changes in stock complex performance or habitat availability can be measured.

This SaSI report has identified one healthy coastal cutthroat stock complex statewide (Table 2). This stock complex is identified and described in more detail in Table 3, and in <u>Part 4 -- Stock Reports</u>.

This designation of a single Healthy stock complex reflects more the lack of data with which to make status determinations than an actual lack of Healthy stock complexes.

<u>Depressed Stocks Complexes</u>

> **Depressed -- A stock complex of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock complex is likely.**

The category of **Depressed** stock complexes is used to identify those stock complexes that are experiencing difficulties that contribute to lower than expected abundance. These stock complexes met one or more of the negative performance criteria, but are likely above the level where permanent damage has occurred to the stock complex. These stock complexes may currently be producing relatively large numbers of fish but have experienced a substantial drop in production or are producing well below their potential. Other stock complexes may be represented by relatively small numbers of individuals and are chronically depressed - forced to a low production level by some combination of biological, environmental, or human-caused factors. It is not unusual for a stock complex to stabilize at a low production level by achieving a balance with the particular set of survival pressures controlling its success. While Depressed stock complexes may not immediately be pushed to Critical status or face extinction, they are vulnerable to any additional negative impacts and can potentially change status very rapidly. Additionally, these stock complexes will constrain fishery harvest opportunity because of their low abundance.

This SaSI report has identified seven Depressed coastal cutthroat stock complexes statewide (Table 2). Individual Depressed stock complexes are identified and described in more detail in Table 5 and Part 4 -- Stock Reports.

Critical Stock Complexes

> **Critical -- A stock complex of fish experiencing production levels that are so low that permanent damage to the stock complex is likely or has already occurred.**

The **Critical** category is reserved for those stock complexes that have declined to a level where the stock complex is in jeopardy of significant loss of diversity or, in the worst case, could face extinction. The loss of within-stock complex diversity includes such factors as a reduction of range (e.g., spawning and/or rearing distribution), shifts in age at maturity, changes in body size, reduction in genetic variability, or lowered disease resistance. Major shifts in these or other attributes can all lead to significant reductions in a stock complex's ability to respond to changing conditions. The usual result is reduced survival and population size. Such stressed stocks complexes can be caught in a downward spiral of ever-increasing negative impacts that can lead to eventual extinction. In contrast, stock complexes in this category might reach an equilibrium with those factors controlling their performance and could display consistent population size and escapements for an extended period. While such stock complexes would appear to be stable, they could be delicately balanced, awaiting just one additional negative impact to push them into failure. Any Critical stock complexes would be in need of immediate restoration efforts to ensure their continued existence and to return them to a productive state.

Some other efforts to identify declining stocks of fish have used minimum population sizes as a quantitative measure of poor stock performance. For example, a report on Sacramento River winter chinook (NMFS 1987), identified 200 spawning fish in a single return year to be the minimum population level to avoid permanent genetic damage to a stock. These minimum population sizes are derived from calculations of the lowest possible numbers of reproducing adults needed to maintain an effective genetic population. While minimum effective population size criteria can be useful in assessing stock status and the likelihood of a stock incurring genetic damage, they were not used in the SaSI report for several reasons. First, the selection of a single minimum population size (e.g., 200 spawners) may create the perception that stocks exceeding the threshold value are not Depressed or Critical. SaSI attempts to compare a stock/stock complex's potential population size and the amount of available habitat to its current status, which means that a stock/stock complex with potential for large population size could theoretically still be in Critical status. Second, it is also possible for very small groups of fish to maintain themselves at productive levels over time, particularly in situations were the population has achieved equilibrium with a limited amount of habitat. Finally, coastal cutthroat stocks composed of small numbers of fish are often extremely difficult to enumerate, particularly in large water bodies. If estimates of escapement or population size have questionable accuracy, using a set minimum population size to measure stock performance makes the criterion difficult or impossible to apply. However, low population estimates can be an important indicator of stock condition and will require more detailed assessments of status and information needs.

No Critical coastal cutthroat stock complexes have been identified in this SaSI report (Table 2). Again, this may be more a reflection of the lack of data with which to make status determinations than lack of critical stock complexes.

Unknown Stock Complexes

Unknown -- There is insufficient information to rate stock complex status.

If sufficient trend information was not available or could not be used to assess current status, stock complexes were rated as **Unknown**. Stock complexes rated as Unknown may be rated as Healthy, Depressed, Critical, or Extinct once more information is available. We do not know to what extent the large number of Unknown stock complexes represent historically small populations.

There is an immediate need to collect information on Unknown stocks. Historically small populations or currently small populations could be especially vulnerable to any negative impacts.

This SaSI report has identified 32 coastal cutthroat stock complexes of Unknown status statewide. Stocks complexes rated as Unknown represent the largest status category of coastal cutthroat in Washington State (Table 2). Unknown stock complexes are identified and described in more detail in Tables 3, 4, and 5 and in Part 4 -- Stock Reports.

Extinct Stock Complexes

Extinct -- A stock complex of fish that is no longer present in its original range, or as a distinct stock elsewhere. Individuals of the same species may be observed in very low numbers, consistent with straying from other stock complexes.

This SaSI report identifies extant coastal cutthroat stock complexes and makes no focused effort to identify and assess past extinctions. The past loss of stocks is an important historical fact that challenges resource management effectiveness. It would be difficult, however, to assemble any kind of comprehensive listing of past extinctions because many of these losses occurred prior to the time that enumeration programs were initiated. Since SaSI is an inventory of the current status of wild salmonid stocks/stock complexes, the inclusion of known past extinctions is not emphasized, but is referenced in documented cases as a reminder of the consequences of ignoring stock status.

The Extinct rating is included here to identify any current and future losses of stocks/stock complexes identified during the annual review and inventory of Washington's wild salmonids. No Extinct stock complexes have been identified to date. The Extinct rating will be applied if a stock complex whose escapement or harvest is currently being tracked is found in the future to have been extirpated within its native range.

STOCK COMPLEX STATUS SUMMARY

Of a statewide total of 40 stock complexes identified in this inventory, 1(2%) was rated as Healthy, 7 (18%) were rated as Depressed, 0 (0%) were rated as Critical, and 32 (80%) were rated as Unknown. The number of stocks in each category in different regions of the state is also presented in Table 2.

More detailed examination and planning will be done for those coastal cutthroat stock complexes requiring priority attention as part of salmonid restoration in Washington (see Part 3 -- Current and Future Actions).

Table 2. Regional summary of Washington State coastal cutthroat stock complex status.

	Healthy	Depressed	Critical	Unknown	Extinct
PUGET SOUND					
North Puget Sound	1	0	0	7	0
South Puget Sound	0	0	0	4	0
Hood Canal	0	0	0	2	0
Strait of Juan de Fuca	0	0	0	3	0
TOTAL	1	0	0	16	0
COASTAL					
North Coast	0	0	0	6	0
Grays Harbor/Willapa Bay	0	0	0	6	0
TOTAL	0	0	0	12	0
COLUMBIA RIVER					
Lower Columbia	0	7	0	4	0
WASHINGTON STATE					
40 TOTAL STOCK COMPLEXES	1	7	0	32	0
PERCENT OF TOTAL	2%	18%	0%	80%	0%

Table 3. Puget Sound and Strait of Juan de Fuca cutthroat stock complex list presented by river basin

PUGET SOUND			
NORTH SOUND	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Sumas	Unknown	Wild	Unknown
North Puget Sound Tribs.	Native	Wild	Unknown
Nooksack	Native	Composite	Unknown
Whatcom Creek	Unknown	Composite	Unknown
Samish	Unknown	Wild	Unknown
Skagit	Unknown	Wild	Unknown
Stillaguamish	Mixed	Composite	Healthy
Snohomish	Mixed	Composite	Unknown
SOUTH SOUND	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Duwamish/Green	Native	Wild	Unknown
Puyallup	Native	Wild	Unknown
Nisqually	Native	Wild	Unknown
Western South Sound	Native	Wild	Unknown
HOOD CANAL	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
East Hood Canal	Native	Wild	Unknown
West Hood Canal	Native	Wild	Unknown
STRAIT OF JUAN DE FUCA	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Eastern Strait	Native	Wild	Unknown
Mid-Strait	Native	Wild	Unknown
Western Strait	Native	Wild	Unknown

Table 4. Coastal Washington cutthroat stock complex list presented by river basin.

WASHINGTON COAST			
NORTH COAST	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Ozette	Native	Wild	Unknown
Quillayute	Native	Wild	Unknown
Hoh	Native	Wild	Unknown
Queets	Native	Wild	Unknown
Raft/Quinault	Native	Wild	Unknown
Moclips/Copalis	Native	Wild	Unknown
GRAYS HARBOR	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Humptulips	Native	Wild	Unknown
Chehalis	Native	Wild	Unknown
WILLAPA BAY	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
North/Smith Cr./Cedar	Native	Wild	Unknown
Willapa	Native	Wild	Unknown
Mid-Willapa Bay	Native	Wild	Unknown
Naselle/Bear	Native	Wild	Unknown

Table 5. Columbia River coastal cutthroat stock complex list presented by river basin.			
COLUMBIA RIVER			
LOWER COLUMBIA	**STOCK ORIGIN**	**PRODUCTION TYPE**	**STOCK STATUS**
Grays	Native	Wild	Depressed
Abernathy Creek/Germany Cr/ Mill Cr/Coal Cr	Native	Wild	Depressed
Elochoman/Skamokawa Cr	Native	Wild	Depressed
Cowlitz	Native	Wild	Depressed
Coweeman	Native	Wild	Depressed
Toutle	Native	Wild	Depressed
Kalama	Native	Wild	Depressed
Lewis	Native	Wild	Unknown
Salmon Cr	Native	Composite	Unknown
Washougal	Native	Composite	Unknown
Small Tribs from Lewis to Bonneville	Native	Wild	Unknown

PART 3 -- CURRENT AND FUTURE ACTIONS

As previously discussed, stock status inventories such as this volume are the first step in salmonid recovery and provide a foundation for implementation of the Wild Salmonid Policy (WSP). The challenge faced by fish managers, legislators, and concerned citizens is how to implement the WSP to accomplish this goal. This report's introduction outlines some difficult issues affecting the region's wild stocks. Defining and managing future change (e.g., urban growth, land-use activities, fisheries) will be at least as difficult as creating technical solutions. **Because habitat, harvest, hatchery and other species impacts all contribute to wild stock status, coordinated management of these factors provides comprehensive strategies for restoring healthy stocks and fisheries.** Recent calls for an ecosystems approach to the ESA indicate a need for a system-wide look at watersheds and the various species they support to develop a broad, landscape approach to restoring depleted wild stocks. A hierarchy of responses will be needed. Some measures may be designed to reap broad regional benefits (e.g., changes in Canadian and U.S. fishery management regimes); some may be at a watershed level (e.g., habitat protection and restoration); while others may be very stock-specific measures (e.g., targeted habitat restoration and harvest enforcement efforts). Clearly, none of the region's management tools alone will solve the problems facing wild stocks. They must be used in concert to provide a reasonable chance for successful stock restoration, or recovery. State and tribal managers have adopted this integrated management philosophy as an approach to challenging the present and improving the future.

The potential for success will be affected by several key factors. One important element is the availability of adequate funding. Fish managers are faced with the deteriorating ability to maintain their fiscal resource base on the one hand, and a need to improve wild stock status on the other. Potential budget reductions in many programs such as harvest management and habitat protection would result in many of the same negative consequences that wild stock restoration is intended to prevent, including risks to wild stocks and further reductions in harvest opportunity. Fish management entities will have varying abilities to tackle priority wild stock issues, and the scope and degree to which salmonid recovery can be implemented successfully will be limited without significant, new funding support. Besides adequate fiscal resources, a necessary willingness must exist to tackle difficult resource management issues and adapt new approaches to complex problems. For instance, the long-term status of fishery resources ultimately will be determined by public support and willingness of land-use regulators to deal effectively with growth management and land/water-use issues. Resolving conflicts between stock restoration and habitat loss/degradation is central to maintenance of healthy wild stocks and fisheries.

NEXT STEPS: AN INTEGRATED APPROACH

A future task for fish managers will be for fish managers to prioritize stock and habitat restoration needs based on SaSI and identify where important information is lacking. A related activity will be to develop public understanding of the implications of depleted stocks and support for their restoration. The public distribution of the 1992 SASSI report, the 1997 and 1998 SaSI for bull trout and Dolly Varden, and this SaSI report is intended to present information on salmonid stocks and their status to interested citizens.

While the objectives for the subsequent steps have been identified, detailed work planning for related tasks is still being completed. The managers' initial thoughts about next steps in salmonid recovery are briefly presented below to help define needs and solicit additional ideas.

Review of Current Resource Management Goals and Objectives

Resource management review steps have been ongoing and will continue with the intent to make significant progress on the following tasks. Specific tasks will include:

- implementation of the Wild Salmonid Policy;
- completion of a cutthroat trout management plan;
- development of wild stock management/genetics policies and associated guidelines; and
- evaluation of costs and benefits of alternative resource management strategies

Effective partnerships among local, state, and federal governments and the public should be initiated and developed to accomplish critical habitat protection needs.

Recovery Programs

Development of wild stock recovery programs for priority salmonid stocks and habitats began during 1993. The intent of these and other efforts has been to develop early action plans for priority stocks or watersheds so that significant, new restoration efforts can commence. Restoration planning and implementation activities will continue into the foreseeable future, driven by stock/habitat status priorities and limited by fiscal resources. The success of restoration efforts will depend largely on the ability to develop strategies that have sufficient public support to proceed with implementation. An essential aspect of this effort will be a broad “multi-public” approach to developing restoration options and building support for the best approaches for solving wild stock problems.

The specific restoration actions taken for a given problem will be determined during plan development and tailored to the specific region, stock, or habitat. Actions could include such things as: habitat restoration, passage improvements, appropriate monitoring and control of interbreeding with exotic species, new management strategies to further manage wild stock exploitation rates, and collaboration with local governments to ensure that coordinated and comprehensive plans developed under the state's Growth Management Act address wild salmonid habitat needs.

Improved Monitoring and Evaluation

Increased monitoring of wild spawning populations in general will be required to address critical information gaps identified through SaSI and to improve assessment of wild stock abundance trends and stock status. New evaluation efforts will also be an important aspect of determining the effectiveness of restoration actions taken, to ensure that they are having positive rather than negative effects and to modify approaches where needed. Criteria will be defined to gauge success, and evaluation efforts will measure performance of specific actions in both short-term and long-term time-frames. Examples of factors to be evaluated could include: fishery variables (e.g., harvest, regulation effectiveness monitoring, and regulation compliance); stock production variables (survival rates during different life history stages impacts of disease, competition and predation, population characteristics such as genetics and age composition, and correlation with limiting factors); and habitat characteristics (long-term watershed productivity, changes in flow characteristics such as frequency and magnitude of flood events, and changes in critical physical habitat variables for the different species).

FUTURE INVENTORIES

The state and tribes intend to review and to update salmonid stock/stock complex status periodically. An overriding conclusion of the technical staff who contributed to the earlier SASSI/SaSI reports and this coastal cutthroat SaSI report was that many stock issues are clouded with uncertainty. The lack of specific data for many coastal cutthroat stock complexes continues to make it difficult to answer questions about stock origin, production type, spawning distribution and status, and conclusions are often based on the collective judgment of the participants. Identified critical information needs will receive a high priority in various data collection programs. Many other questions will require longer term study. Inventories will guide future data collection programs by pointing out stock information deficiencies, and will allow updating and revision of stock status designations as better data become available. Additionally, the systematic review process will function as a tool to measure the short-term and long-term success in rehabilitating priority stocks.

Inventory updates will become a part of the salmonid management cycle for the state agencies and tribes. Stock assessment data (e.g., escapement, population size, and survival) will be assembled and analyzed, and future inventories will be completed on a systematic basis.

The envisioned review process will be relatively simple. Any aspect of the inventory is subject to review and modification as better information or new approaches are developed. For example, screening criteria and the system for rating stock status could be refined or the types of inventory information could be expanded. Further, any new information that can be used to refine the stock/stock complex list will be examined and stocks may be added or deleted from the list based on such things as more thorough spawning ground data or more detailed genetic study (e.g., addition of information on individual life history types). The quantitative information on the stock status profiles will be updated for all stocks for each SaSI iteration. Each stock will be screened for any change in stock status since the previous inventory, and the various stock status lists will be amended. New stock reports will be prepared for any stocks which have changed status, and for all new stocks. Finally, the inventory results will be published in SaSI documents.

Besides the update and review process for specific stocks, managers will consider the utility of comprehensive, regionally focused reviews of management performance throughout Washington. This level of assessment would encourage broader evaluation of status trends and resource management strategies in region-wide contexts that would help identify additional, integrated management opportunities.

CURRENT WILD STOCK PROGRAMS

Numerous resource management activities within the state presently contribute to the maintenance and restoration of wild salmonid stocks and their habitats. Fishery management programs for coastal cutthroat trout include providing harvest management and enforcement of fishery regulations. Other activities that indirectly affect coastal cutthroat include stock assessment, environmental review and permitting, habitat restoration, public information, and education. Many of these efforts are cooperative programs, and often also involve active participation of private citizens; municipal, county, state, and federal agencies; public and private utilities; private businesses; and others. In addition, some programs that affect wild stocks are not the direct responsibility of fishery management agencies, e.g., land-use planning and regulation.

It would be impractical to provide a comprehensive listing in this report of all activities designed to restore and maintain wild salmonid stocks and habitats. However, it is important to highlight several examples of programs that address issues of habitat management and water quality and quantity on a broad scale, which are intended to improve stock status in the region. Numerous governments and agencies share responsibility and regulatory authority for land use actions, but none are responsible for coordinated land-use management designed to benefit anadromous salmonids (PFMC 1992). Improved coordination, funding, implementation, and evaluation of programs designed to protect and restore salmonid habitat are important aspects of any long-term restoration strategies. Examples of existing programs include:

- The Timber/Fish/Wildlife (TFW) forum - This forum involves a number of state, tribal, and federal agencies, as well as forest industry and other groups concerned with forest land management. Important activities include review of forest practice applications, watershed analysis, and in-stream wetlands protection. Several priority watersheds have been designated for intensive TFW studies contain stocks rated as Critical in the 1992 SASSI report.

- The Washington Board of Natural Resources has adopted the Department of Natural Resources's Habitat Conservation Plan. One component of the Habitat Conservation Plan is a riparian conservation strategy to maintain and restore fresh water salmonid habitat through protection of wetland, riparian ecosystems, and unstable hill slopes; improved road network management; and reduction of the impacts of rain or snow floods by maintaining a portion of drainage basins as hydrologically mature forests.

- The WDFW Integrated Landscape Management project in the Lewis and Kalama River basins is a watershed-based, multi-species approach that engages private landowners, the public, and fish and wildlife managers in generating a comprehensive management plan for fish, wildlife, and their habitat. Key fish and wildlife species have been identified, and population and habitat objectives are being developed.

- The Washington State Conservation Commission approved ecosystem standards for state-owned agricultural and grazing lands in 1994 at the direction of the 1993 Washington Legislature. Standards were adopted for stream water temperature, fish passage, riparian zone management, and fine sediments in spawning gravel. These standards will help protect coastal cutthroat trout.

- The Washington Board of Natural Resources has adopted the Forest and Fish Report, an agreement between state natural resource agencies and the timber industry intended to provide more protection for fish habitat on state and private forest lands.

Subsequent steps in salmonid rebuilding will include a specific inventory and review of ongoing habitat, harvest management, and hatchery programs as part of the review of current management goals and objectives. Ongoing programs, including those noted above, will be evaluated in more detail at that time.

PART 4 -- STOCK COMPLEX REPORTS

This section provides detailed information on each coastal cutthroat stock complex presented in this SaSI report. It includes descriptions of the rationales for stock complex definitions, origins, and status ratings. General information is also included on factors affecting production. Information presented is based on the framework and procedures outlined in Part 1 -- Stock Complex Definition and Identification and Part 2 -- Stock Assessment and Status sections of this report.

Stock Complex Reports

In this and subsequent sections, the terms “stock” and “stock complex” are used synonymously . Each stock identified in SaSI is the subject of a report which presents detailed descriptions of the rationales for the stock definitions in a **Stock Definition and Origin** section (which reviews distribution, timing, and biological characteristics) and highlights any related uncertainties or caveats. Stock origin is also addressed with discussions of the probable genetic make-up of each stock, and possible impacts of introduced fish. The **Stock Status** section of these reports assesses trends in survival or production for each stock and discusses the data used to measure current status. Stock status ratings are also presented.

The individual stock reports also contain a two-page "stock profile". The first page of each profile is a **Stock Definition Profile** which summarizes the available evidence relevant to the three criteria used in defining individual stocks. **Spawning distribution** is shown on a generalized basin map, and distinct distribution is noted if applicable. **The spawning distribution maps are not intended to be comprehensive maps of all spawning locations for a stock.** Rather, their purpose is to support stock complex distinction based on differences in geographic distribution of spawners. **These maps should not be used to make fine-scale land-management decisions.** **Timing** of adult returns (where applicable) and spawning is presented in graphic form, and again any distinctions (differences among stock complexes) are identified. Any information on unique **biological characteristics** is summarized at the bottom of the stock definition page. A **Stock Status Profile** presents stock complex status data in tabular and graphic form. These data sets vary by stock, depending on the nature of available stock-specific information. The purpose of the numerical data is to describe the stock production trends, and these summaries may include data for escapement or other measures of population size. Average run-size distribution, that is, apportionment of the run to escapement and to fisheries or other sources of mortality, is not available for coastal cutthroat. The final section of the stock profiles presents a summary of stock origin, production type, and current status.

The **Factors Affecting Production** section summarizes the possible impacts of harvest management, habitat status, and fish culture programs. The **Harvest Management** section is a general discussion of the fisheries regulations that impact each stock. The **Habitat** section reviews the general condition of the habitat used by each stock, and identifies specific environmental problems known to impact stock production. The **Hatchery** section discusses key fish culture programs in the areas utilized by each stock, and outlines possible interactions between wild fish and hatchery fish. Some stock reports contain a **Species Interactions** section which describe interactions between coastal cutthroat and established native or introduced species which share coastal cutthroat spawning and rearing habitat. **These discussions on factors affecting production are meant only to provide a very general overview of the type of problems faced by a stock**. More detailed examinations of these topics will be developed for those stocks requiring priority attention as part of the overall salmonid recovery planning and Coastal Cutthroat Management Plan when it is finalized (see Part 3 -- Current and Future Actions).